

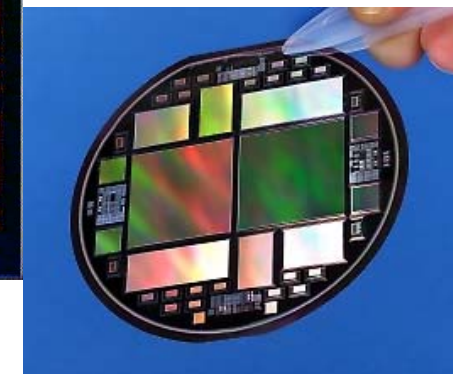
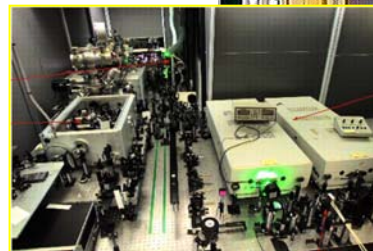
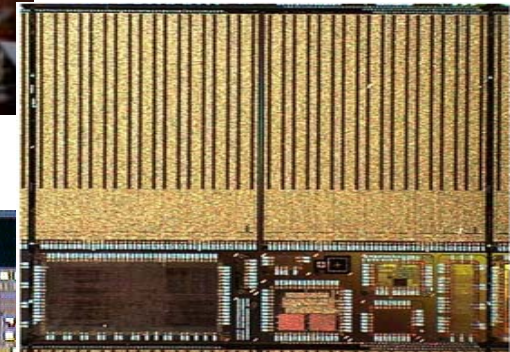
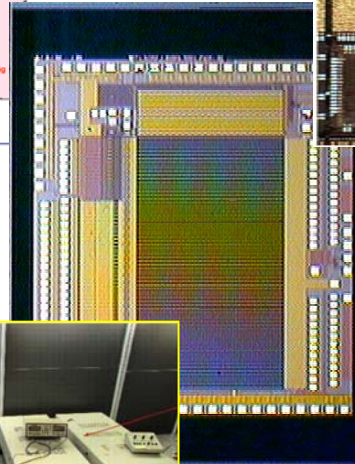
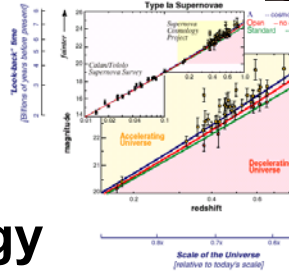
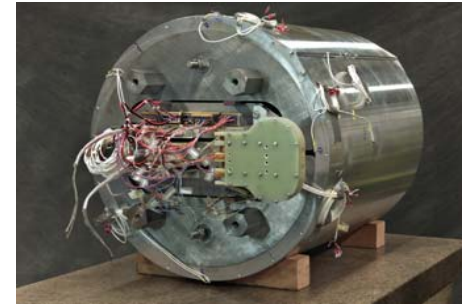
# Berkeley HEP Program

**Jim Siegrist**  
**March 6, 2003**

# LBNL: Creativity and Innovation



- Time Projection Chamber
- SVX chip and first Si vertex detector in hadron collider environment
- Asymmetric B Factory concept
- Smart pixels for ATLAS
- CCDs for astronomy & astrophysics
- SNe cosmology – dark energy
- New paradigm for HEP analysis software
- Leaders in laser acceleration
- Leaders in high field magnets



# Combined with Highly Leveraged Infrastructure



- Strong support of research program by Berkeley theory group
- Outstanding faculty supported by UCB
- Small but dedicated full-time scientific staff
- Accelerator infrastructure supported by multiple SC offices
- Excellent technical resources
  - Engineering Division (e.g. IC design)
  - Computing Division (NERSC)
  - Large machine shops, clean room facilities
- Outstanding crop of postdocs and students
- Close collaboration with university groups outside Berkeley

***Synergy leads to creativity  
and innovation***

# To Address the Fundamental Questions



- **Mass [Higgs, SUSY,  $\nu$  oscillations]**
  - ATLAS, CDF, D0, KamLAND, antarctic  $\nu$*
- **Matter [CP Violation]**
  - BaBar, CDF*
- **Origin and Fate of the Universe**
  - CMB, SCP, SN Factory, SNAP*

# Addressing Limits to Accelerator-based HEP



- **Ultimate practical fields on Superconductors**
- **Ultimate accelerating gradients**
  - All optical accelerators*
- **Ultra-high quality beams**
  - LC damping ring, bright ion sources and injector systems*

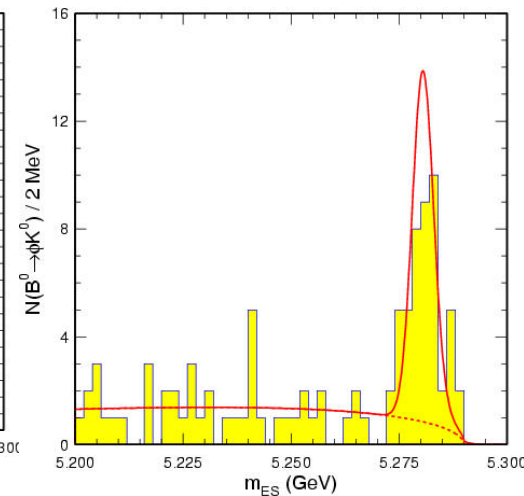
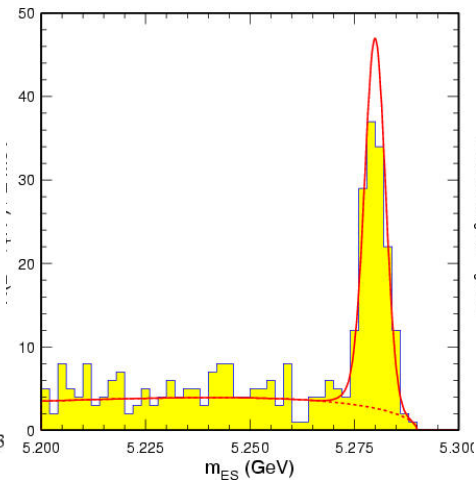
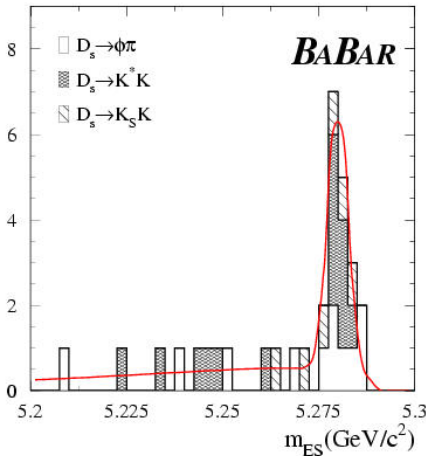
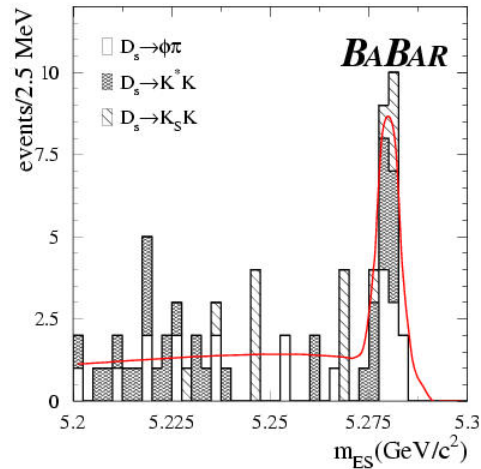
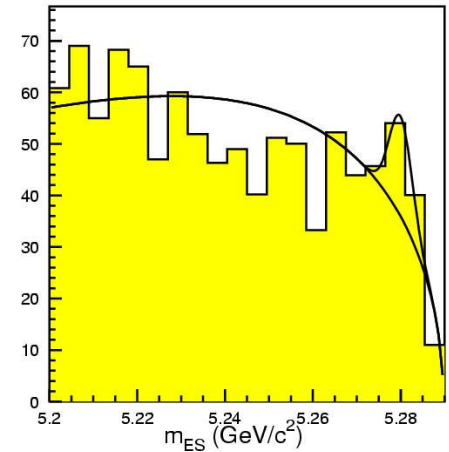
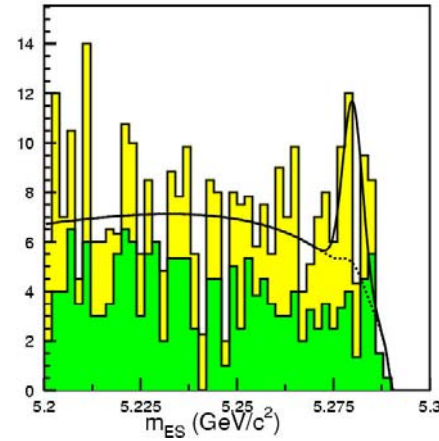
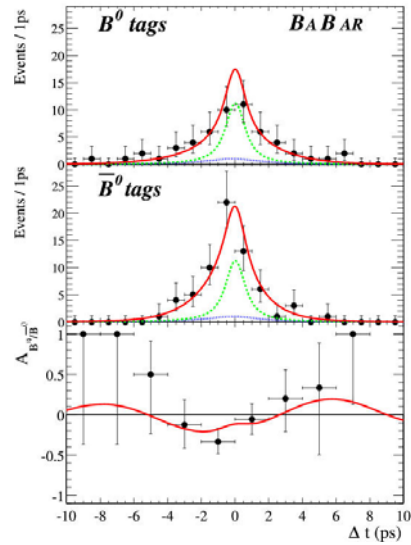
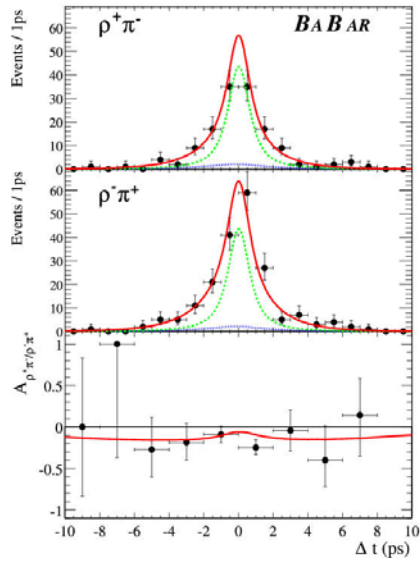
# Today's Program



- You will hear how we participate in:
  - Physics from 'start to finish'
  - Projects at different phases of development
- Neutrino & quark flavor physics
- ATLAS construction, SC magnet development
- Laser plasma accelerator development
- Report on SNAP R&D progress
- I'll say a few words on some things you missed, and highlight important elements of the program



# Many New Results from BaBar





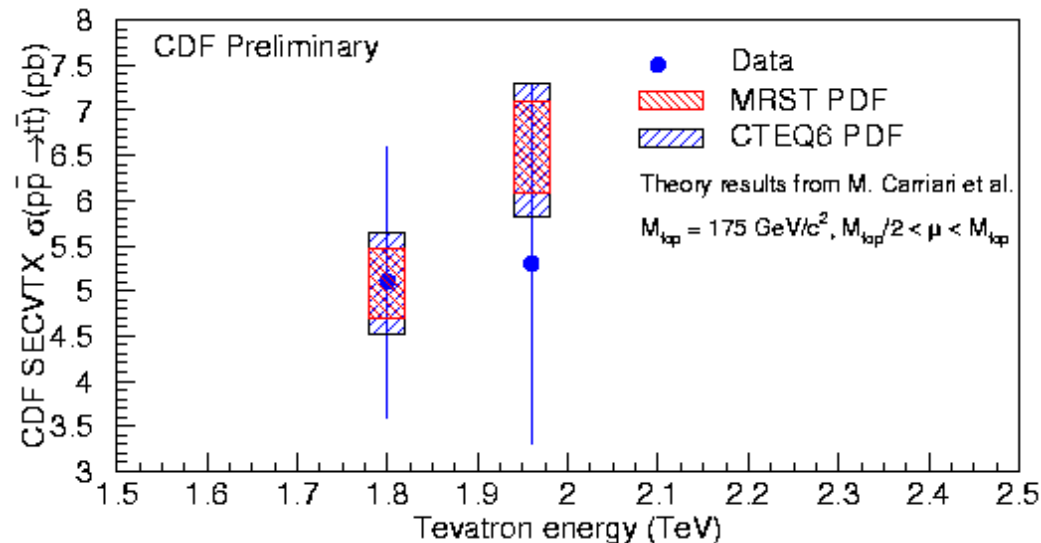
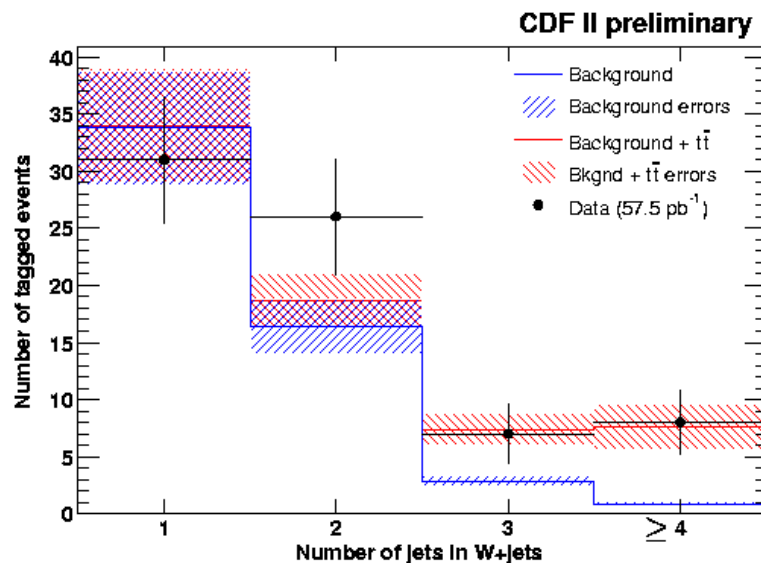
# LBLN Contribution to CDF

## $\sigma_{t\bar{t}}$ with b-tagged events



Top cross section measured in Run II using 50 pb<sup>-1</sup> of data with SVXII.  
At least 1 jet tagged as a b quark is required (*essential use of silicon – major LBNL contribution*)

- Re-discovery of Top Quark in Run II (15 tagged events found)
- $t\bar{t} \rightarrow W^+W^-b\bar{b} \rightarrow l\nu q\bar{q}'b\bar{b}$
- Tagging  $\varepsilon_b = 45 \pm 5\%$  (will improve soon!)
- Establishment of tools for the high Pt physics at CDF

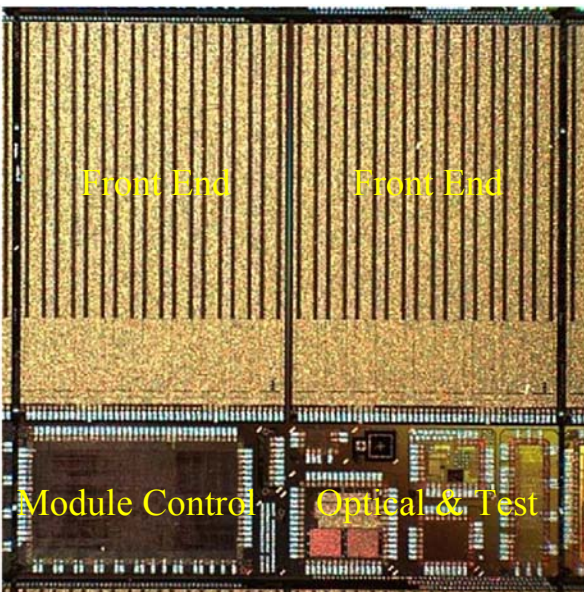


$$\sigma_{t\bar{t}} = 5.5 \pm 1.9 \text{ (stat)} \pm 0.8 \text{ (sys) pb}$$



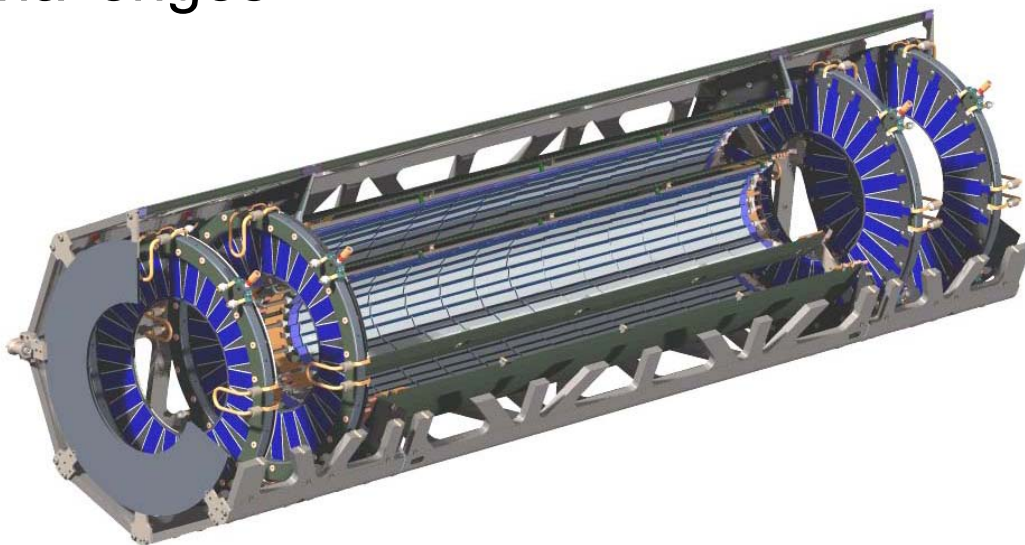
# ATLAS Entering Production

Pixel Integrated Circuits



- ATLAS strips entering production now
- ATLAS pixels fully into production this year
- Computing efforts focused on data challenges

Mechanical structure fabrication underway.

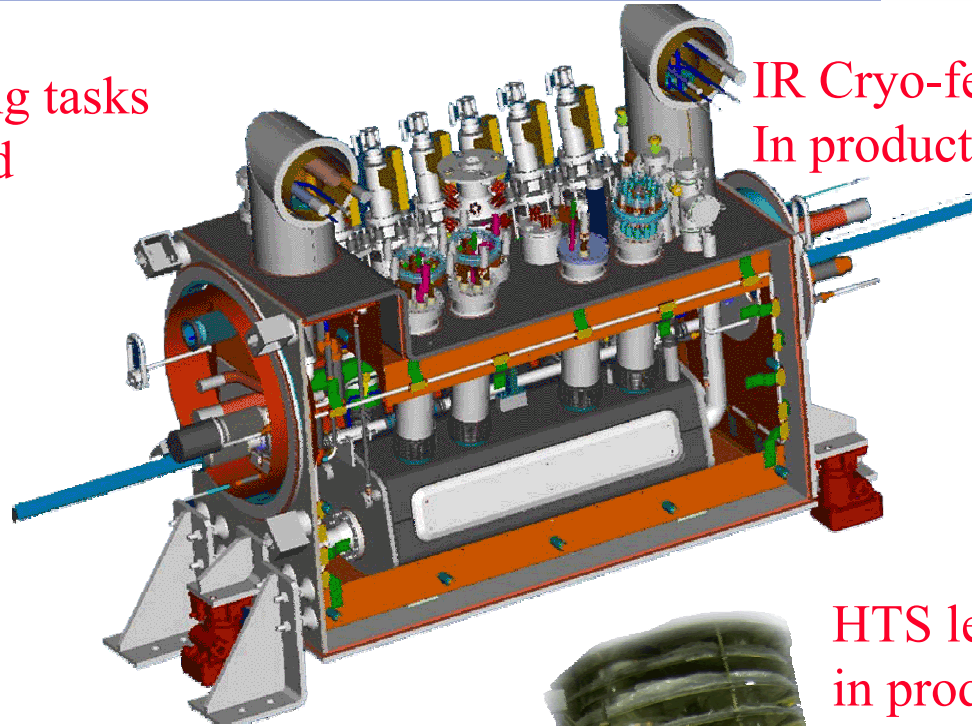


***We must meet our commitments in ATLAS***

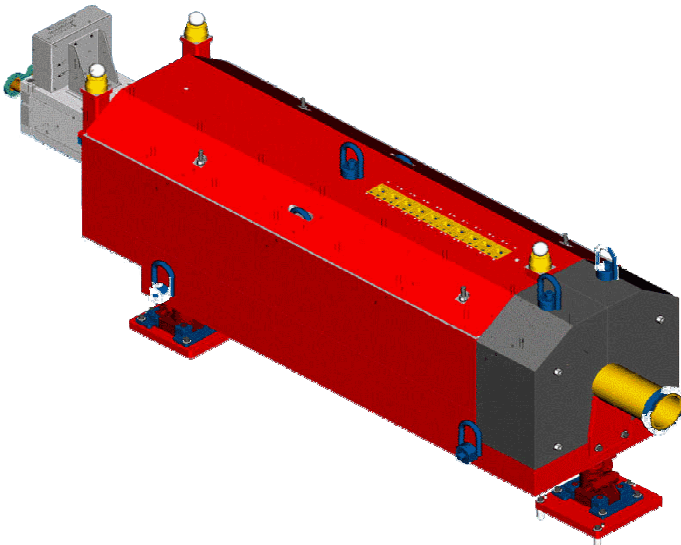
# US-LHC Accelerator Project ~80% Complete



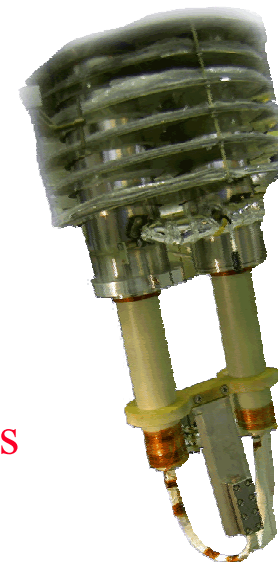
All cabling tasks completed



IR Cryo-feedbox:  
In production



TAS & TAN absorbers  
Near completion



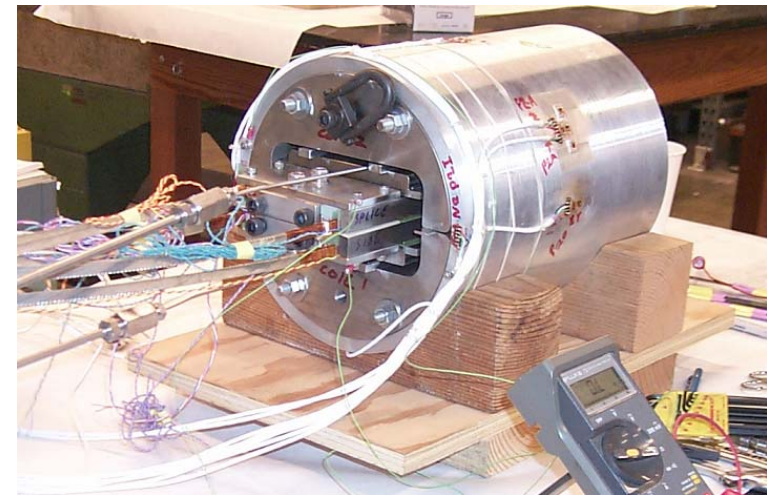
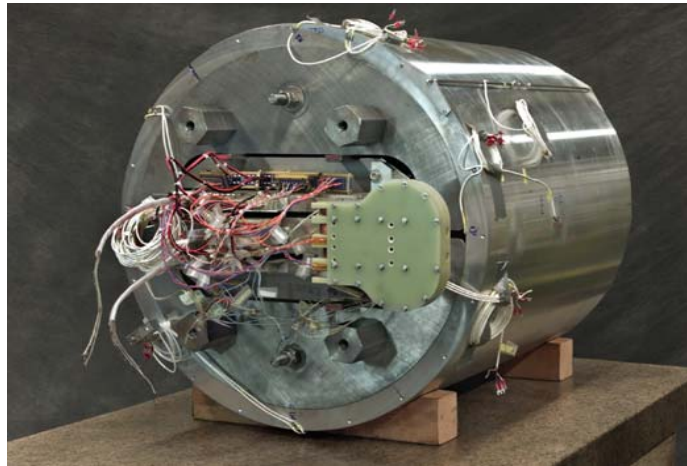
HTS leads  
in production

# LBNL Superconducting Magnet Program



- High Field Magnet Program at LBNL has established  $\text{Nb}_3\text{Sn}$  as the enabling technology for the next generation IR quadrupoles and dipoles for the LHC

World Record  
Dipole Field  
14.7 Tesla  
(S. Gourlay)



Sub-scale magnets allow rapid prototyping of new design options

- National Conductor Program has more than tripled  $\text{Nb}_3\text{Sn}$  current density with respect to ITER cable.  
(Scanlan)



# Linear Collider

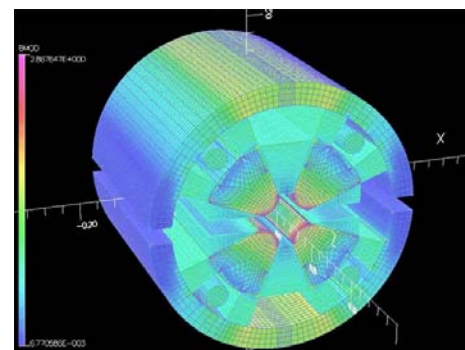
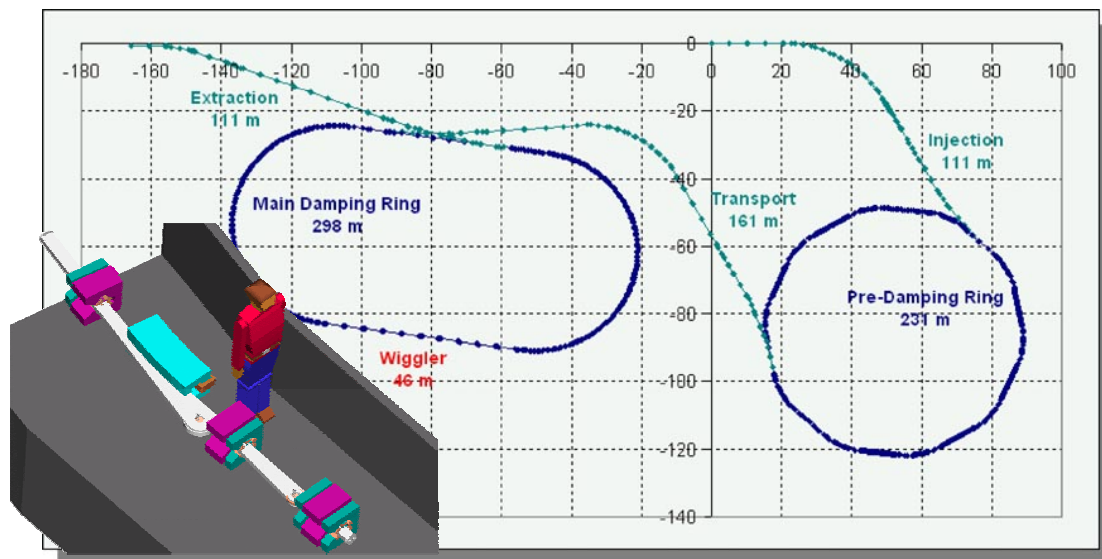
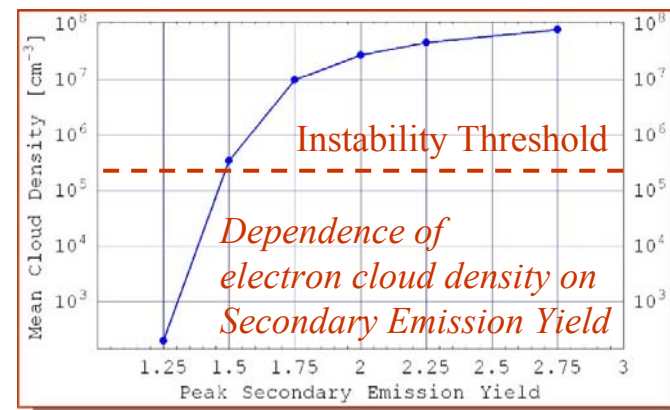


- Accelerator Design – Damping Ring Complex (K. Robinson)
- Large Snowmass involvement (Hinchliffe, Murayama, ...)
- Active roles in guiding the effort – 2 of 8 members of US LC Executive Committee; US LC Steering; Vertex Working Group Co-Leader (Roe)
- Time scale is so long that LC detector design warrants a futuristic R & D effort

# LBNL ownership of NLC damping ring R&D



- Detailed lattice designs meet demanding specifications
- Designs of all major components & systems at sufficient level to show feasibility
- Luminosity limitations due to collective & beam dynamics



# Laser Driven Accelerator R&D at I'OASIS Lab

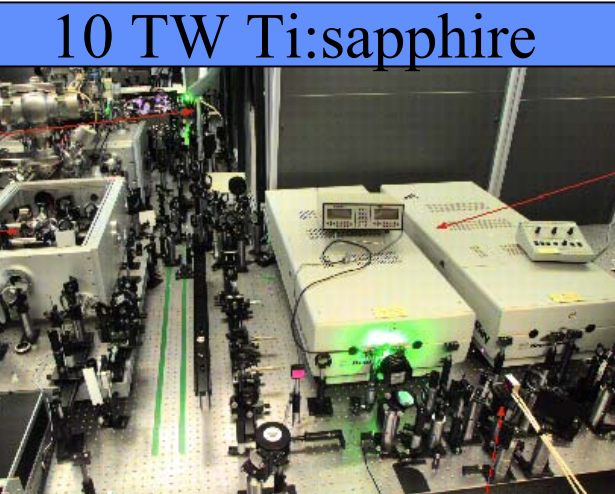


Test bed for R&D concepts towards 1 GeV module of a laser accelerator

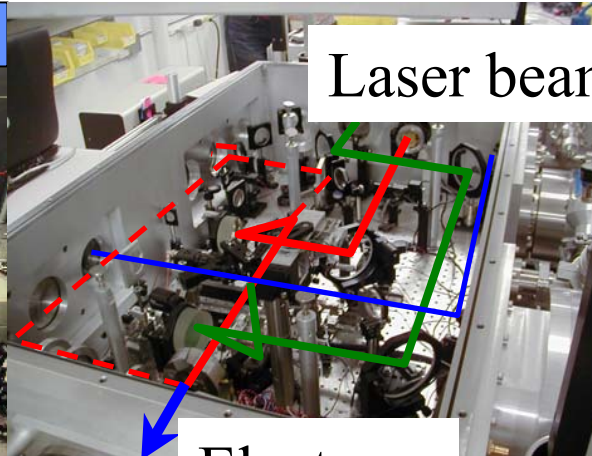
Training of postdocs and graduate students

Facility includes 10 TW, 50 fs laser system @ 10 Hz (100 TW under development)

10 TW Ti:sapphire

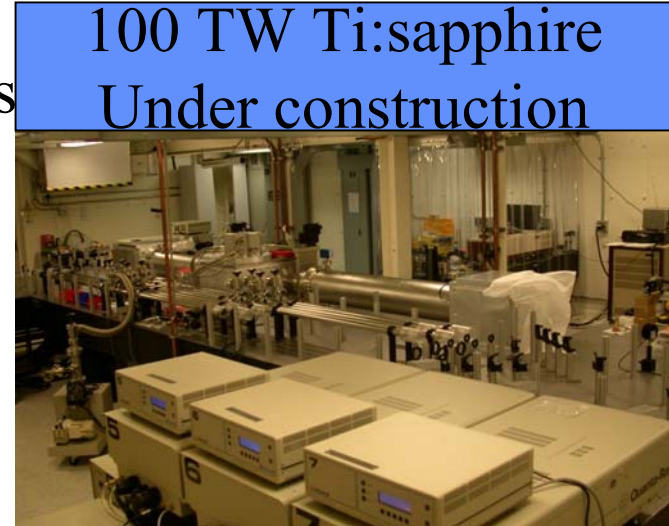


Laser beams

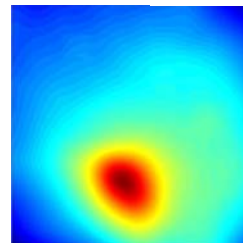
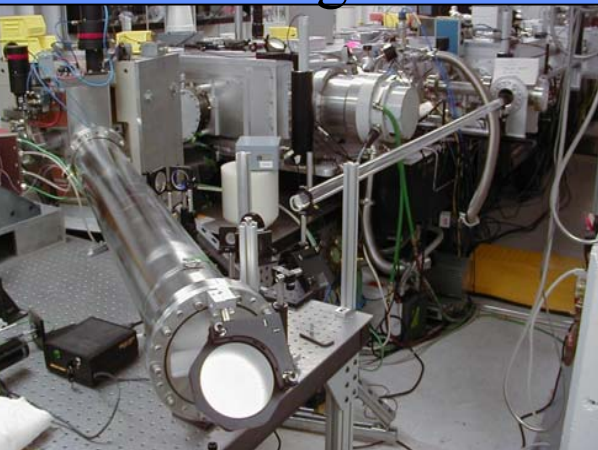


Electrons

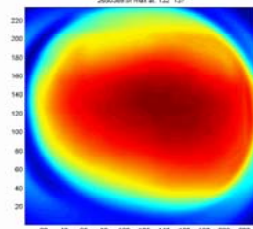
100 TW Ti:sapphire  
Under construction



Shielded target room



High energy  
< 10 mrad



Low energy  
100 mrad

Control Room

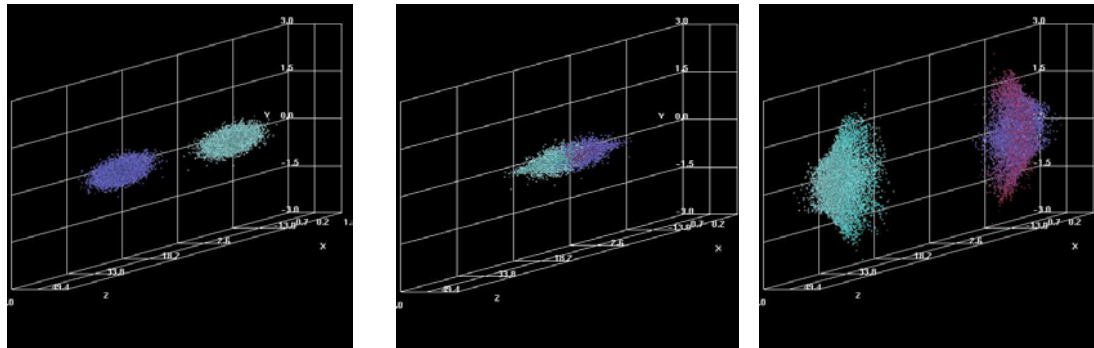




# SciDAC activities support HENP priorities



- Four terascale accelerator modeling codes
- Modeling beam-beam effects in Tevatron & LHC
- Collaboration to model FNAL booster
- NLC damping ring design using MaryLie to simulate beam dynamics in wiggler magnets
- Modeling plasma accelerator experiments at l'OASIS lab and SLAC



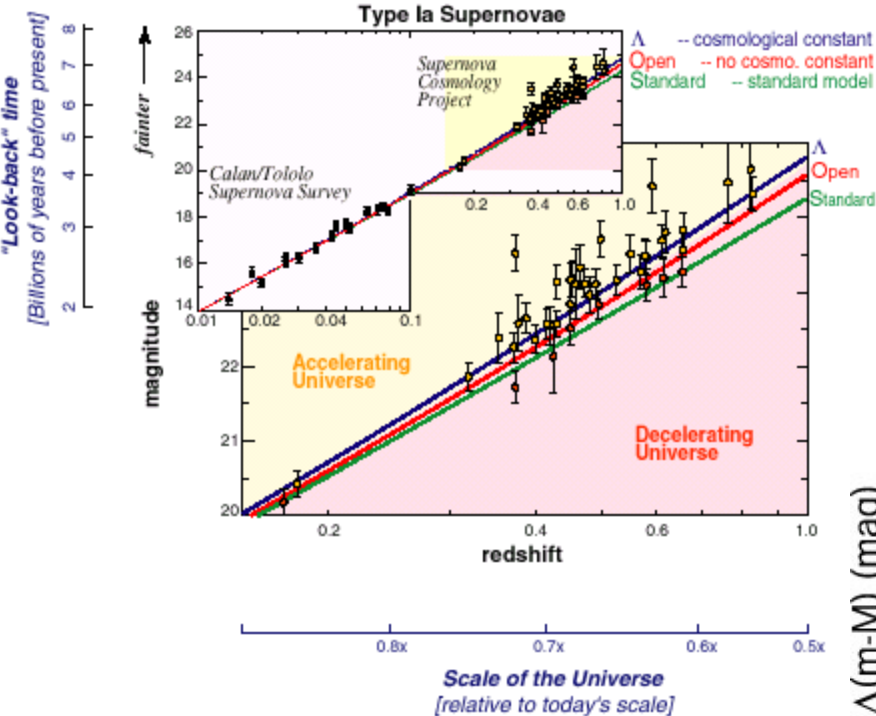


# Pioneers in Supernova Cosmology



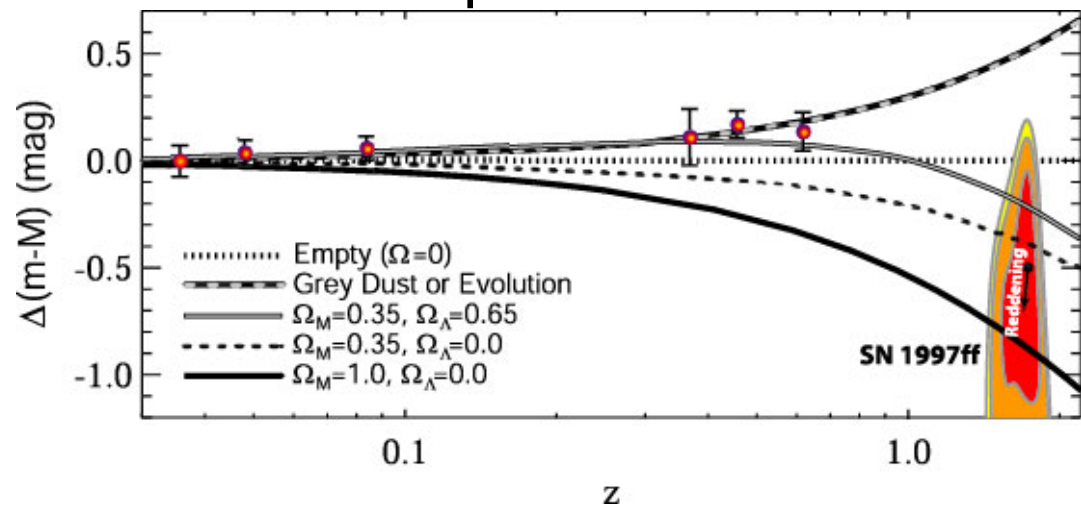
## Supernova Cosmology Project

Perlmutter, et al



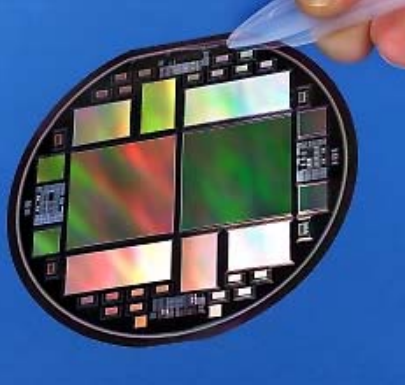
LBNL established the new field of distant supernova cosmology, discovered acceleration of universe.

New very distant supernova supports dark energy/cosmological constant interpretation.



Next Steps: SN Factory – a nearby SN search; SNAP

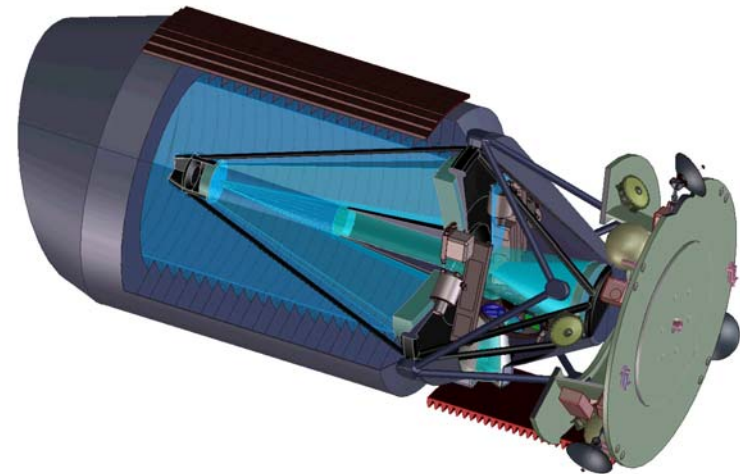
# SNAP: An Example of LBNL Innovation at Work



- **CCD development – A new instrument for science**
  - **Very heavy support from LBNL discretionary funds**
  - **New capability with broad potential impact outside HEP**
- **Berkeley's Space Sciences LAB (SSL)**
  - **Extensive experience in space missions**
  - **SSL & LBNL form engineering backbone for the team**

**FY03: CDØ, progress on open R&D issues, move toward conceptual design and costing in FY04.**

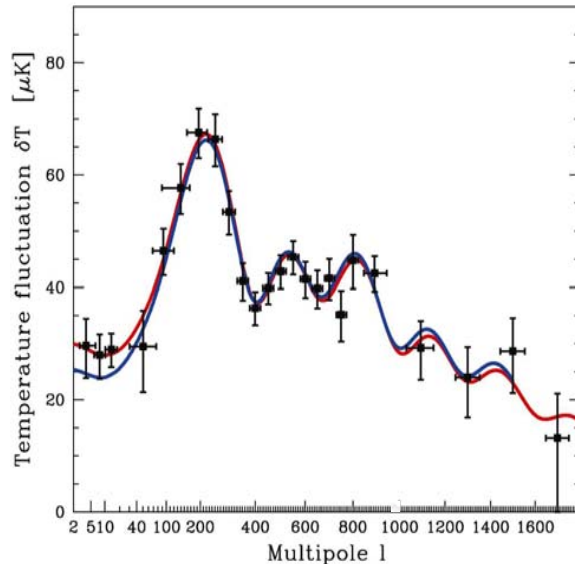
**Large FY04 increase supports development of the Dark Energy research program.**



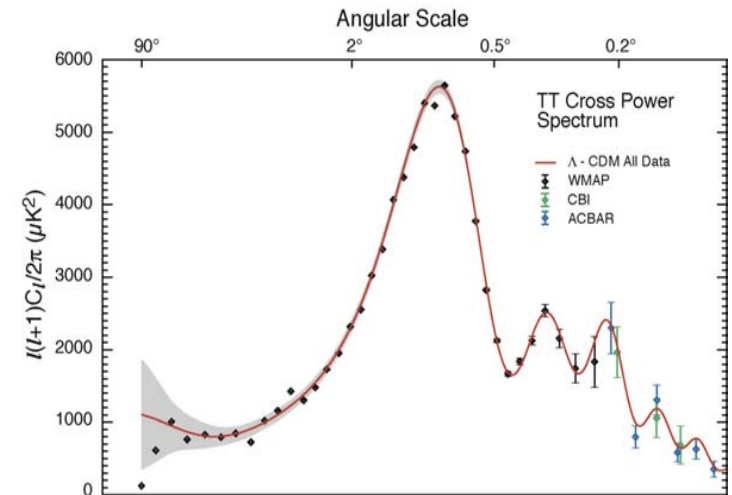
# Current CMB Anisotropy Status



Pre-WMAP Data



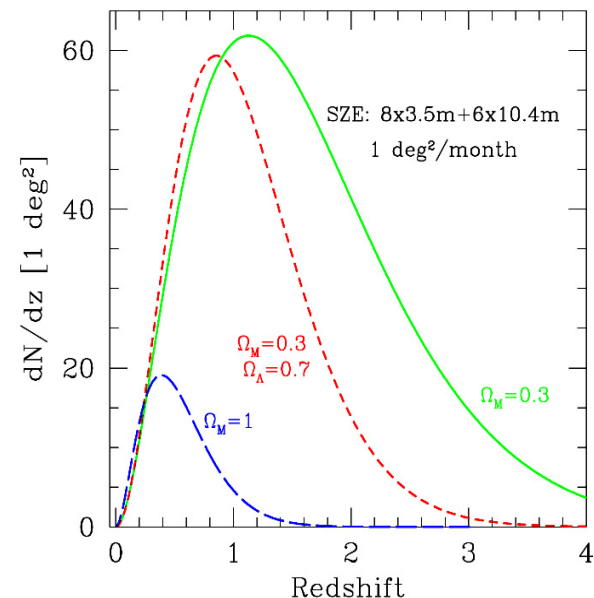
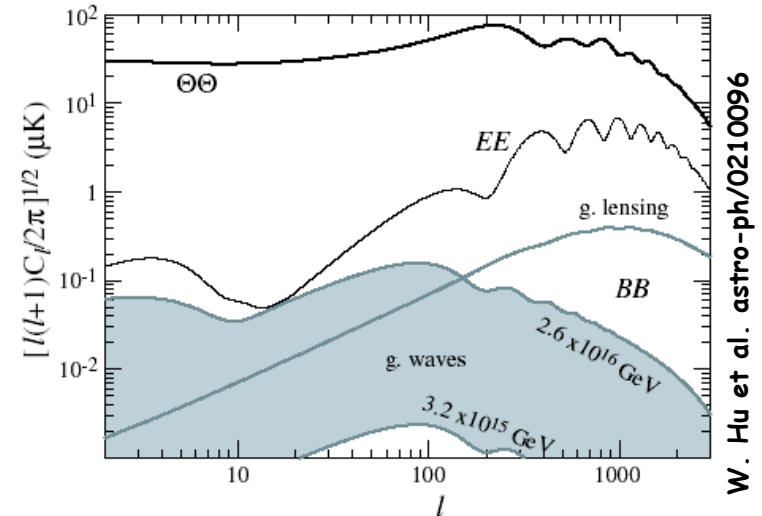
WMAP+ACBAR/CBI Data



- **Rich History of CMB measurements at LBNL/UCB**
  - COBE: now confirmed by WMAP
  - MAXIMA (UCB, LBNL, et al.), BOOMERanG (CIT, LBNL-NERSC, et al.): now confirmed by WMAP
  - ACBAR (UCB et al.): extends WMAP range
  - Continuing work on Planck Surveyor Mission

# Future Areas

- **CMB Polarization**
  - Search for  $10^{16}$  GeV Physics from Inflation
  - Better determination of cosmological parameters
- **Galaxy Cluster Cosmology**
  - Sunyaev-Zel'dovich Effect
    - Hot ionized cluster gas scatters CMB photons causing spectral distortion
  - Measure the evolution of the Universe
    - Complementary w measurements of SNAP



# Particle Data Group



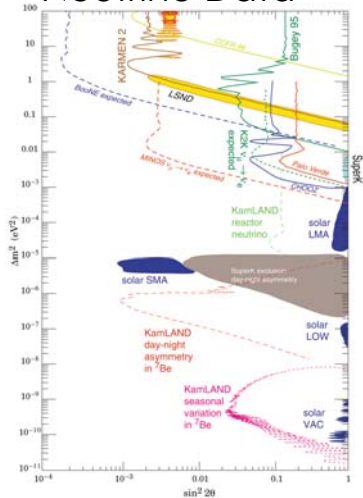
**Review of Particle Physics  
Census/Survey Activities  
Education/Outreach Programs**

**More than 100 authors, 700 contributors.  
Substantial CERN, Japan & other involvement.  
Resembles leading a medium-sized experiment.**



PDG Collaboration meeting

## Neutrino Data



**RPP has 650 new papers, 2000 new measurements, 98 reviews.  
Book is 900 pages, booklet is 300 pages.  
28,000 Booklets, 14,000 RPP books, website: 5-10 million hits/year.  
10,000 citations.**



**Improved coverage though vital PDG workshops:  
Neutrino, CKM, and Extra-dimensions Workshops**



**Growing coverage of Astrophysics and Cosmology**

# Service to the Community



**Nygren, Perlmutter  
Gaillard  
Barnett**

**National Academy of Sciences  
National Science Board  
Vice-Chair, APS Calif. Sec.  
VP AAPT No. Calif. Sec  
Chair, ATLAS Outreach**

**Roe, Jackson  
Roe  
Trilling  
Sessler  
Barletta**

**HEPAP  
FNAL PAC, DESY Scientific Council  
APS Past-President  
APS Past-President  
Executive Committee, APS DPB  
Chairman, USPAS**

**Gourlay  
Leemans  
Barletta, Turner  
Hinchliffe**

**LARP magnet program head  
Chair, ICFA Panel on Advanced & Novel Accelerators  
US-LHC working group  
US ATLAS Physics Coordinator,  
ATLAS deputy physics coordinator**

**Siegrist  
Oddone  
Zisman**

**US ATLAS Institutional Board Convener  
MUCOG, LHC oversight  
Muon Collider/ $\nu$ , Program Manager**

**We look forward to great physics!**

- *CP violation*
- *Higgs*
- *SUSY*
- *Dark energy*
- *Extra dimensions and even more*

**And advanced accelerators technology for future physics**

- *All optical accelerator at 1 GeV and beyond*
- *Practical Superconducting materials & magnets at >15 Tesla*